

Revisiting the continuum of resistance theory in the digital age: A comparison of early and delayed respondents to the Norwegian Counties Public Health Survey

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Abstract

Background

The continuum of resistance model's premise is that delayed respondents to a survey are more similar to non-respondents than early respondents are. For decades, survey researchers have applied this model in attempts to evaluate and adjust for non-response bias. Despite a recent resurgence in the model's popularity, its value has not been assessed in a large online population health survey.

Methods

Respondents to the Norwegian Counties Public Health Survey in Hordaland, Norway, were divided into three groups: those who responded within 7 days of the initial email/SMS invitation (wave 1, n = 6950); those who responded after 8 to 14 days and 1 reminder (wave 2, n = 4950); and those who responded after 15 or more days and 2 reminders (wave 3, n = 4045). Logistic regression analyses were used to compare respondents' age, sex and educational level between waves, as well as the prevalence of poor general health, life dissatisfaction, mental distress, chronic health problems, weekly alcohol consumption, monthly binge drinking, daily smoking, physical activity, low social support and receipt of a disability pension.

Results

The overall response to the survey was 41.5%. Respondents in wave 1 were more likely to be older, female and more highly educated than those in waves 2 and 3. However, there were no substantial differences between waves for any health outcomes, with a maximal prevalence difference of 2.6% for weekly alcohol consumption (wave 1: 21.3%, wave 3: 18.7%).

Conclusions

There appeared to be a mild continuum of resistance for demographic variables. However, this was not reflected in health and related outcomes, which were uniformly similar across waves. The continuum of resistance model is unlikely to be useful to adjust for nonresponse bias in large online surveys of population health.

Background

Differences are likely between people that respond to public health surveys and those that do not. Among non-respondents, there is commonly a disproportionate number of young,(1-8) male,(2-10) and unmarried people,(1, 2, 5, 8, 11-14) as well as those with lower education,(1, 2, 5-8, 10, 12-15) and lower socioeconomic status.(5, 6, 8, 11, 13, 16) Non-respondents are also more likely to be smokers, (1, 4, 10, 14, 17-19) and to have different patterns of alcohol consumption,(10, 16, 20-22) poorer physical and/or mental health,(5, 7, 9, 10, 23) and higher rates of mortality and morbidity.(20, 24-29) If researchers fail to

account for nonresponse bias, prevalence estimates (in particular)(9) and analyses of associations between variables will likely be incorrect.

As nonresponse bias is less of a problem as survey response rates approach 100%, researchers often use a variety of strategies to encourage participation, such as sending multiple reminders to non-respondents, encouraging them to complete the survey. Nevertheless, few large-scale public health surveys achieve a response rate adequate to avoid substantial nonresponse bias, which – depending on how much respondents and non-respondents differ in the outcomes of interest – is estimated to be between 70% and 90%.(30) As participation rates in epidemiologic studies have been declining over time,(2, 31) it is increasingly important for researchers to identify and account for nonresponse bias when summarising and analysing data. Obviously, this is a major challenge because information on non-respondents is often unavailable, particularly for the outcomes of interest.

Researchers have sought methods to account for nonresponse bias for decades. In 1939, Pace proposed that the existence and direction of nonresponse bias in a given survey could be detected by comparing the responses of people who respond quickly to those who only respond after repeated contact attempts (delayed respondents).(32) This approach, often referred to as the “continuum of resistance” model,(33) is based on the presumption that people who are slow or reluctant (i.e. resistant) to complete a questionnaire are more similar to non-respondents than early respondents are.

The continuum of resistance model has resurfaced periodically in the literature since its proposal, despite having performed inconsistently under empirical testing. Some early studies supported the existence of a continuum of resistance for outcomes of interest;(34, 35) however, others have found that early and delayed responders do not differ at all,(36, 37) that associations between delayed responders and non-responders are weak,(33) or that a continuum of resistance exists for demographic variables but not outcomes of interest.(38) Recently, the model has been applied in a number of surveys of alcohol consumption and other health behaviours,(3, 13, 39-42) which have demonstrated significant and consistent differences between early and late respondents, for both demographic variables and outcomes of interest. In several of these surveys, investigators subsequently used weightings based on delayed respondents’ data to adjust their prevalence estimates, in an effort to account for nonresponse bias.(3, 13, 39, 41, 42)

Given the apparent value of the continuum of resistance model in these recent studies, and because we are unaware of any investigations of the utility of the model in large public health surveys involving digital data collection, we compared early and delayed respondents of the internet-based Norwegian Counties Public Health Survey. We hypothesized that there would be a relatively higher proportion of male, young and less-educated people among late responders, and that a continuum of resistance would exist for health outcomes and behaviours related to these demographic differences.

Methods

Study design and setting

The Norwegian Counties Public Health Survey is a cross-sectional study of self-reported health, health-related behaviours, quality of life, and local health-related factors in the Norwegian general population. The survey was launched by the Norwegian Institute of Public Health in 2015 and is currently ongoing, covering each of Norway's 11 counties every 4 years. We performed this investigation using data collected in the county of Hordaland between the 10th of April and the 13th of June 2018. The survey was approved by the Norwegian Data Protection Authority. This study is a secondary analysis of previously collected data, and according to the Health Research Act, additional ethical approval was not required.

Participants

A random sample of 38 458 Hordaland County residents was selected from the National Population Register and invited to participate in this survey. To be eligible for selection, residents needed to be over 18 years of age and have their mobile telephone number and email address registered in the Norwegian Agency for Public Management and eGovernment. The sample size was determined to allow for adequate subgroup analysis on a municipal level (minimum of 400 participants per subgroup), with an expected response of 30% to 40%.

The questionnaire was distributed to the sample by email and short message service (SMS) using a secure platform.⁽⁴³⁾ Non-respondents received reminders with a link to the questionnaire on the 7th and 15th day after the initial distribution, and the survey remained open for 5 weeks and 3 days.

Variables

- **Response to questionnaire invitation:** All members of the invited sample were categorised as survey *respondents* or *non-respondents*. Respondents were further categorised into one of three groups based on when they completed the questionnaire: (1) *Wave 1* - completed the questionnaire prior to the first reminder; (2) *Wave 2* - completed the questionnaire between the first and second reminders; (3) *Wave 3* - completed the questionnaire after the second reminder.
- **Gender:** Male or female, as recorded in the national population register.
- **Age:** Categorised as *18-29, 30-39, 40-49, 50-59, 60-69* and *70 or older*
- **Education:** Respondents were categorised according to their on highest-attained level of education: *junior high school* (up to and including 10th grade), *senior high school* (up to and including 13th grade), *university or university college (less than 4 years)*, and *university or university college (4 or more years)*
- **Poor general health:** Respondents were categorised as having poor general health if they reported having bad or very bad general health on a 5-point scale including *very good, good, neither good nor bad, bad* and *very bad*.

- **Dissatisfied with life:** Respondents were categorised as being dissatisfied with life if they reported being quite dissatisfied or very dissatisfied on a 5-point scale with the alternatives *very satisfied*, *quite satisfied*, *neither satisfied nor dissatisfied*, *quite dissatisfied*, and *very dissatisfied*.
- **Mental distress:** Based on the five items' version of the Hopkins Symptom Checklist (HSCL-5), with four response options ranging from *not at all* (1 point) to *extremely* (4 points). We classified respondents with a mean item score greater than 2 as having high levels of mental distress.(44)
- **Chronic health problems:** Respondents who reported having a chronic health problem or disability that has lasted at least 6 months (including seasonal and intermittent problems).
- **Daily smoking:** Respondents who reported that they smoked tobacco on a daily basis
- **Alcohol consumption:** Based on the consumption questions of the Alcohol Use Disorders Identification Test (AUDIT).(45) Respondents were categorised into those who did and did not drink alcohol more than once a week, and those who did and did not consume six or more standard drinks (10g ethanol) in a single session more than once a month (monthly binge drinkers).
- **Receiving disability pension:** Respondents who reported that they currently receive a disability pension
- **Low social support:** Respondents who reported that they experienced low social support using a previously described categorisation of the Oslo-3 Social Support Scale (OSS-3).(46)
- **Physical activity:** Based on the International Physical Activity Questionnaire (IPAQ). Respondents were classified as being physically active if they performed moderate or vigorous physical activity daily, or walked for at least 30 minutes every day.

Statistical analyses

We calculated response rates by age group and gender for each response wave. The proportion of responses returned in waves 1, 2 and 3 was calculated for age, gender and education. We performed logistical regression analyses to assess associations between respondents' wave (independent variable) and general health, life satisfaction, mental distress, social support, smoking, alcohol consumption, chronic health problems, receiving a disability pension (dependent variables).

All analyses were conducted in R (47). We used the packages `nnet`(48) to fit multinomial log-linear models, `margins`(49) and `effects`(50, 51) to generate marginal effects, and `ggplot2`(52) to produce figures. A 95% confidence interval (CI) was calculated for all estimates, and we used a significance threshold of .05.

Results

The overall response rate to the questionnaire was 41.5%, with 44% of responses received in wave 1, 31% in wave 2, and 25% in wave 3. The response rate was substantially higher among females (46%) than among males (37%), and it was higher in older age groups (Fig. 1).

[Figure 1 near here]

The age distribution of the invited sample, each response wave and non-responders is shown in Fig. 2. Younger people were under-represented and older people were over-represented among respondents, particularly in waves 1 and 2. Similarly, males were under-represented among respondents, particularly in waves 1 and 2 (Fig. 3).

[Figure 2 near here]

[Figure 3 near here]

There were small differences in the distribution of respondents' educational level between each wave, with wave 1 respondents having a relatively higher level than wave 2 and 3 respondents (Fig. 4).

[Figure 4 near here]

Health outcomes

Table 1 and Fig. 5 show the proportion of respondents in each wave that reported poor general health, life dissatisfaction, mental distress, chronic health problems, drinking alcohol more than once per week, monthly binge drinking, daily smoking, physical activity, low social support, and receiving a disability pension. Table 2 shows the results of pairwise comparisons of each wave using logistic regression analyses.

[Figure 5 near here]

Table 1
Prevalence (% [95% CI]) of health and health-related outcomes among respondents in waves 1, 2 and 3

	Wave 1	Wave 2	Wave 3
Poor general health	7.8 [7.1, 8.5]	6.5 [5.7, 7.3]*	7.5 [6.6, 8.5]
Dissatisfied with life	4.2 [3.7, 4.7]	3.0 [2.5, 3.6]*	3.9 [3.3, 4.6]
Mental distress	11.5 [10.7, 12.4]	9.9 [9.0, 10.9]*	12.3 [11.2, 13.5]#
Chronic health problems	10.1 [9.3, 10.9]	9.0 [8.1, 9.9]	8.8 [7.8, 9.8]*
Alcohol > 1x week	21.3 [20.2, 22.4]	19.5 [18.3, 20.8]*	18.7 [17.3, 20.0]*
Monthly binge drinking	17.8 [16.7, 18.8]	16.5 [15.3, 17.7]	18.4 [17.0, 19.8]
Daily smoking	8.2 [7.4, 8.9]	9.2 [8.3, 10.1]	9.6 [8.6, 10.6]*
Physically active	35.6 [34.3, 37.0]	36.8 [35.1, 38.4]	35.0 [33.2, 36.8]
Low social support	11.6 [10.7, 12.4]	10.5 [9.6, 11.5]	12.1 [11.0, 13.2]
Disability pension	8.2 [7.5, 9.0]	7.7 [6.9, 8.5]	7.9 [7.0, 8.9]
* Sig. different to wave 1 (p < 0.05)			
# Sig. difference between wave 2 and wave 3 (p < 0.05)			

Table 2
Results of logistic regression models (odds ratios [95% confidence interval])

	Wave 1 (ref.)	Wave 2	Wave 3
Poor general health	1.00	0.82 [0.70, 0.96]*	0.96 [0.82, 1.13]
Dissatisfied with life	1.00	0.72 [0.57, 0.90]*	0.94 [0.75, 1.17]
Mental distress	1.00	0.84 [0.74, 0.97]*	1.08 [0.94, 1.24]
Chronic health problems	1.00	0.88 [0.77, 1.01]	0.86 [0.74, 1.00]*
Daily smoking	1.00	1.14 [0.99, 1.32]	1.19 [1.02, 1.39]*
Alcohol >1x week	1.00	0.90 [0.81, 0.99]*	0.85 [0.76, 0.95]*
Monthly binge drinking	1.00	0.91 [0.82, 1.02]	1.05 [0.93, 1.17]
Physically active	1.00	1.05 [0.96, 1.15]	0.97 [0.88, 1.07]
Low social support	1.00	0.90 [0.79, 1.03]	1.05 [0.92, 1.20]
Disability pension	1.00	0.93 [0.80, 1.08]	0.96 [0.82, 1.13]
*p < 0.05			

Discussion

To our knowledge, this is the first application of the continuum of resistance model to a large online public health survey. We investigated differences between respondents who completed the questionnaire within the first 7 days (wave 1), those who completed it after 8 to 15 days and one reminder (wave 2) and those who completed it after 16 or more days and two reminders (wave 3). For demographic variables, we identified differences between waves that were consistent with previous literature.(1–10, 12–15) However, differences in health outcomes and behaviours were small between waves and unlikely to be useful in correcting for nonresponse bias.

Overall, females and older people were more likely to respond to the questionnaire than males and younger people were. This was most pronounced among wave 1 and 2 respondents, whereas wave 3 more closely resembled the invited sample, containing a higher proportion of males and younger people. However, it is important to note that for sex and age, the composition of wave 3 more closely resembled waves 1 and 2 than it did the non-responders.

For education, our findings were similar. There was a slight trend towards wave 1 respondents being more highly educated than those in wave 2 and 3. However, the difference between respondents and non-respondents is likely to be far more substantial than the small differences between response waves. Although we lacked direct information on the education level of non-respondents, data from Statistics Norway show that 35% of Hordaland county residents have tertiary education, and that 24% have only completed junior high school.(53) These proportions differ markedly from our results (52% and 13%, respectively), suggesting that non-respondents had far lower levels of education than respondents did.

Based on the continuum of resistance model, we expected that late responders would display an overall pattern of poorer health across health outcomes. This has been found in a number of recent studies. For example, compared to early responders, late responders have been found to have a 21–68% higher prevalence of monthly binge drinking,(3, 39, 41, 42) a 30% higher prevalence of current smokers,(54) and a 50% higher prevalence of people who complete less than 30 min per day of physical activity.(39) We aligned our outcome definitions to facilitate comparisons with these studies, but did not find the same results. There was no difference between waves in the prevalence of monthly binge drinking or physical inactivity, and for current smoking, the difference in prevalence between waves 1 and 3 was only 1.4 percentage points. Our findings were similar for other health outcomes; in some cases, there were statistically significant but very small prevalence differences between waves, and in others there were none at all.

There are several potential explanations for why we did not find evidence to support a continuum of resistance in our data. Indeed, it is possible that the health status of responders and non-responders is very similar in our population. We believe this is unlikely, particularly considering the findings of Knudsen et al., who, in 2008, reported a substantially higher prevalence of mental and somatic health disorders among non-responders to a health survey conducted in Hordaland county.(9) Our definition of late responders differs from recent studies demonstrating a continuum-of-resistance, which have used more

reminders,(42) longer follow-up periods,(3, 12, 39–41) and/or alternative methods such as telephone calls to contact slow responders.(3, 40, 41) To our knowledge, this is the only continuum-of-resistance study besides those of Kypri et al.(39, 40) to collect data using purely digital means, and it is the first general population survey to do so. It is possible that the barriers to questionnaire completion differ between postal, telephone and internet/smartphone surveys, and that the data collection method has consequences on any eventual continuum of resistance.

This study has limitations that may have affected our findings. First, we had no information about the health status of non-responders, but rather we assumed that there were differences based on previous research. Future studies linking survey data with other sources, such as national registers, are necessary to gain more information on the health status of non-responders. Additionally, to be eligible for inclusion in the survey, people had to have their digital contact information registered with the Norwegian authorities. This introduces a selection bias that is particularly pronounced among older people, as less than 50% of Norwegian residents aged over 75 years are registered, compared to approximately 80% of those aged between 18 and 65 years.(55) It is therefore likely that the health status of the survey sample is more homogeneous than it is in the general population.

Conclusion

In this study, we were unable to identify meaningful differences in reported health and health determinants between early and late survey respondents. Assuming there are true differences in the health status of responders and non-responders, the results of delayed responders provided little help in estimating the direction or magnitude of non-response bias. Keeping the survey open for an extended period and using multiple reminders increased the overall proportion of male, younger and less-educated respondents. However, this did not appear to make the data much more representative.

Declarations

Ethics approval and consent to participate

The survey was approved by the Norwegian Data Protection Authority. This study is a secondary analysis of previously collected data, and according to the Norwegian Health Research Act, additional ethical approval was not required.

Consent for publication

Not Applicable

Availability of data and materials

Data are available from the authors based on application in accordance with Norwegian laws and regulations pertaining to health research and GDPR, and with permission of the Norwegian Institute of Public Health.

Competing interests

The authors declare that they have no competing interests

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Authors' contributions

All authors were involved in planning the study. Data were collected by TSN, LEÅ and JCS. BC analysed the data and wrote the draft manuscript. All authors contributed to and approved the final manuscript.

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Figures

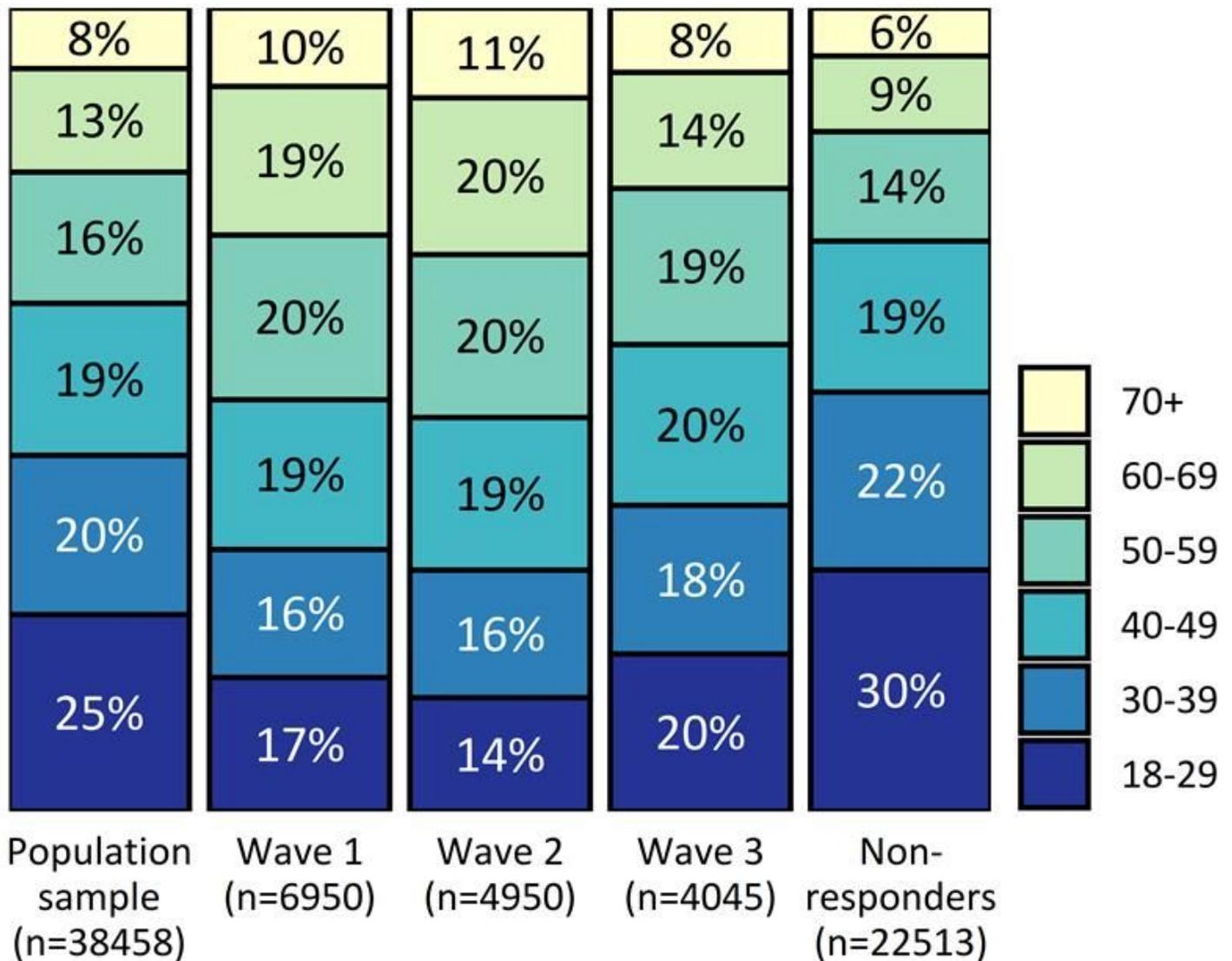


Figure 1

Questionnaire response rate by age group and gender. The overall response rate is shown to the right of each bar, and the response rate for each wave is shown within each segment of the bars.

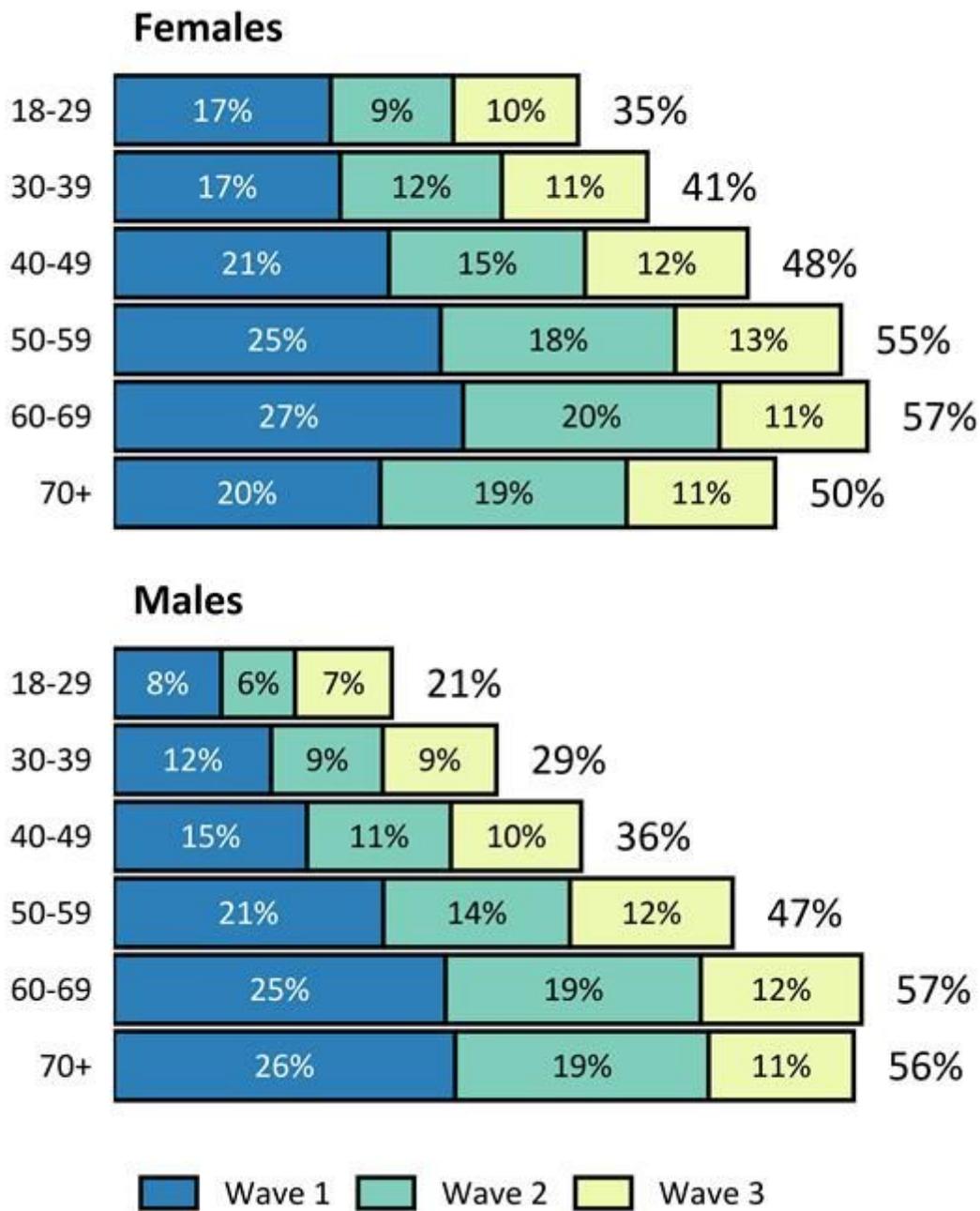


Figure 2

Age group proportions within the invited sample, each response wave, and non-respondents.

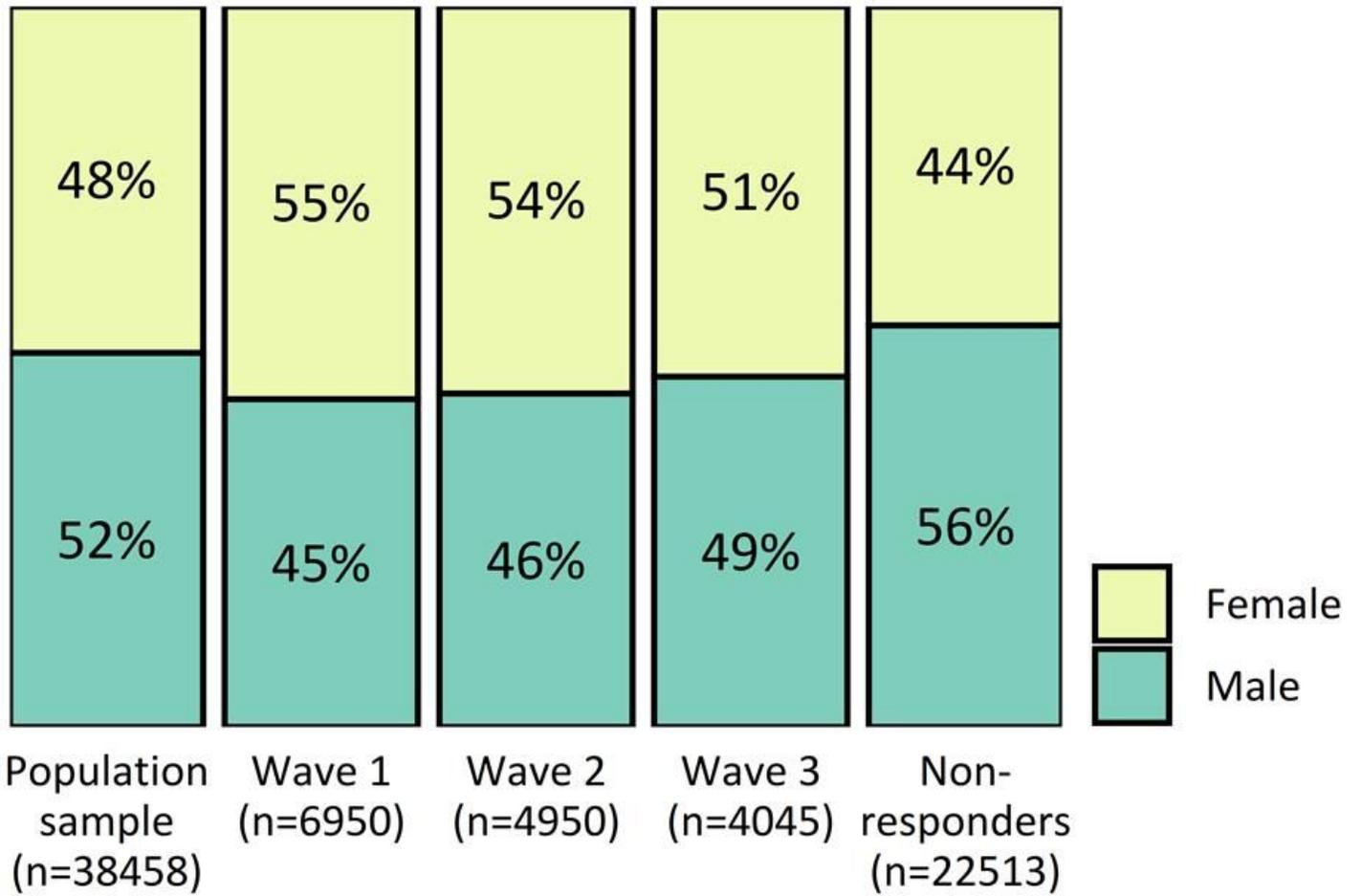


Figure 3

Proportion of males and females within the invited sample, each response wave, and non-respondents

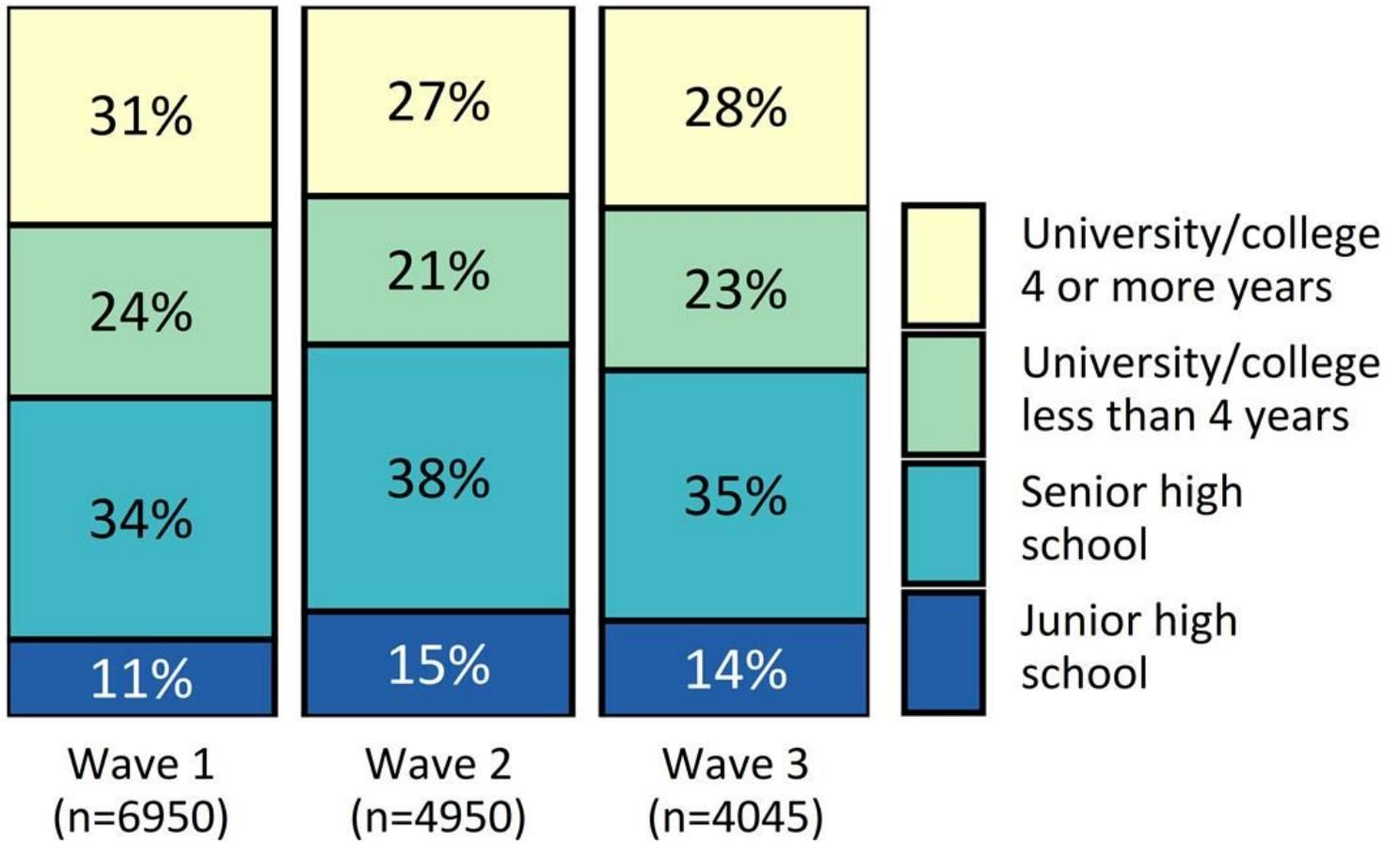


Figure 4

Distribution of educational level in each response wave

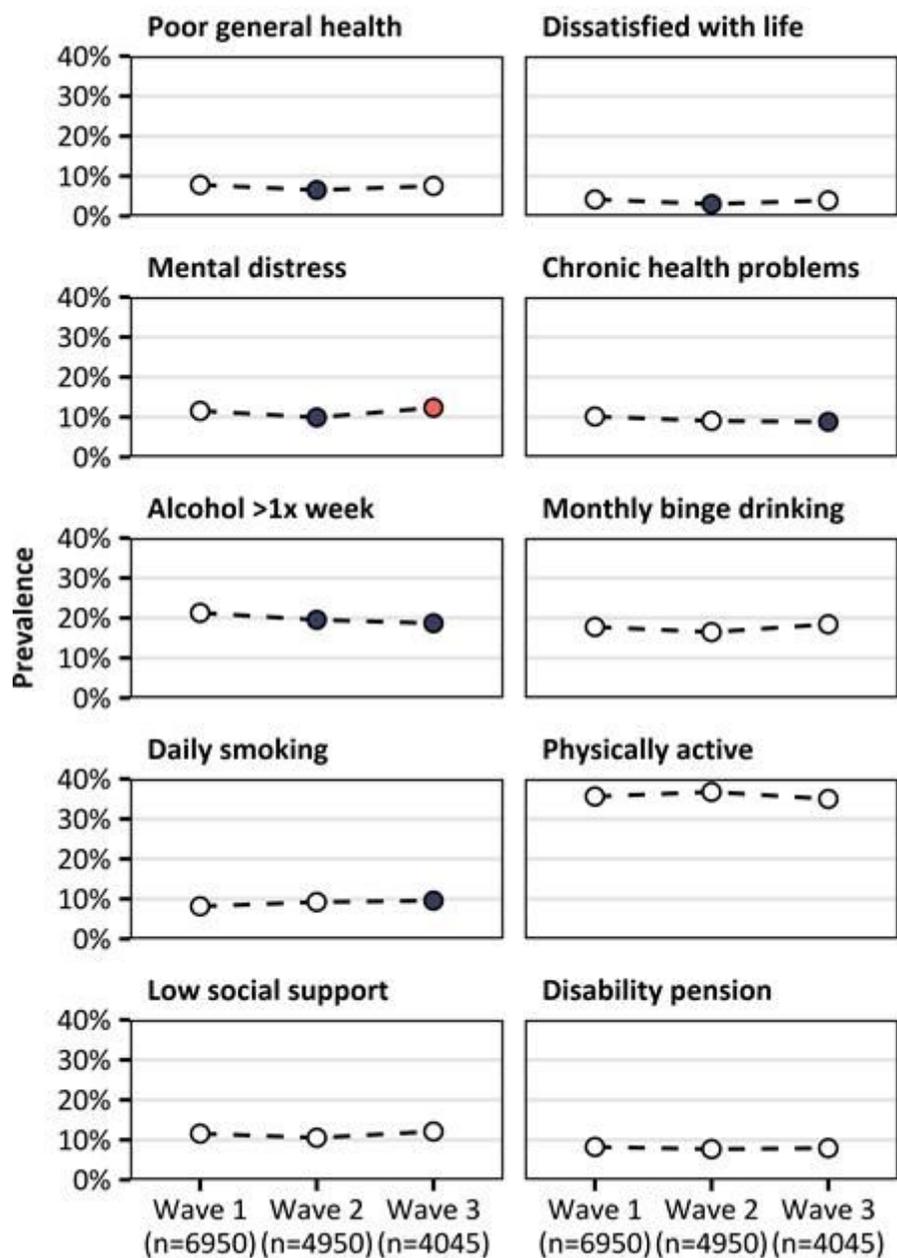


Figure 5

Prevalence of various health and health-related outcomes among questionnaire respondents in waves 1, 2 and 3. Red dots indicate significant differences from wave 1 ($p < 0.05$) and the black dot indicates a significant difference between wave 2 and wave 3 ($p < 0.05$).